RESEARCH DEPARTMENT

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THE BRITISH BROADCASTING CORPORATION
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SUMMARY

During the 1962/63 series of u.h.f. field trials, objective measurements of field strength and subjective observations of picture quality were made at a large number of sites in the London area. This information has been analysed and curves have been prepared which enable the cover of a u.h.f. transmitter to be determined from a knowledge of the sound field strength. However, these predictions of the cover of a u.h.f. transmitter are valid only when the terrain is similar to that in the London area and in this report the possibility of predicting u.h.f. cover in other types of terrain is discussed.

1. INTRODUCTION

Determination of the service area of a u.h.f. transmitter requires a definition of the minimum standard of picture quality acceptable to the viewer. The only practicable way of approaching such a definition is to make use of an agreed subjective scale of picture quality, and for this purpose, the subjective scale shown in Table 1 is generally adopted.

TABLE 1

GRADE	PICTURE QUALITY
1	Excellent
2	Good
3	Fairly good
4	Rather poor
5	Poor
6	Very poor

The grade which different observers will allocate to the same television picture will clearly vary; an engineer experienced in the assessment of picture quality will allocate a higher numerical grade (corresponding to a poorer assessment) than a viewer who is used to viewing under fringe-area conditions. The surveys made

during the Field Trials were, however, carried out by skilled observers and some decision must therefore be made regarding the relation between the gradings allocated and the acceptability of pictures to the viewer.

Experience leads to the conclusion that pictures graded 1, 2 and 3 by skilled observers can without doubt be regarded as acceptable to the viewer. Further, it is probable that a considerable proportion of viewers whose picture would be classified as grade 4 would, in fact, regard the picture as acceptable. It is, however, improbable that pictures classified as grade 5 or grade 6 would be regarded as acceptable.

It is considered that only the assessments of skilled observers in grades 1, 2 and 3 should be regarded as satisfactory and corresponding to acceptable pictures for the viewer. This assumption is considered justified since in the case of co-sited v.h.f. and u.h.f. transmissions, the adoption of too lax a standard of u.h.f. 625-line picture quality could result in the u.h.f. services being regarded by the public as inferior to the existing v.h.f. services.

It is known that in relatively small areas, the picture quality of a u.h.f. transmission can vary considerably and it is therefore necessary to define the service provided by a u.h.f. transmitting station in terms of the percentage of viewers who will receive a satisfactory picture. It is convenient to define the area served by a transmitting station as that which includes all localities in which at least 70% of viewers[1,2] will receive a satisfactory picture. Thus although the proportion of the population throughout the service area who receive a satisfactory picture will be much higher than 70% (95% or more) localities in which 70% of the viewers receive a satisfactory picture will constitute the fringe of the service area.

The u.h.f. field trials carried out in 1957/58[1] and 1962/63[2] were made using transmitters installed at the BBC's Crystal Palace transmitting station. The results therefore give a considerable amount of information regarding u.h.f. cover of the types of terrain encountered in the London area. However, this terrain is not typical of every part of the United Kingdom and it is therefore necessary to know whether the information derived from the field trials can be used in other areas in order to determine:

(a) The approximate service area of a u.h.f. transmitter prior to the carrying out of site tests.

(b) The best form of objective measurement or measurements to make when conducting site tests.

Objective (a) can be achieved only if an objective parameter can be predicted which is reasonably well correlated with subjective picture quality. However, the only parameter that can be predicted with reasonable accuracy is the median field strength and approximate predictions of cover must therefore be based on a correlation between picture quality and median field strength. Thus, prior to the carrying out of site tests, predictions of u.h.f. cover can only be made in terrain in which there is a good correlation between field strength and subjective picture quality.

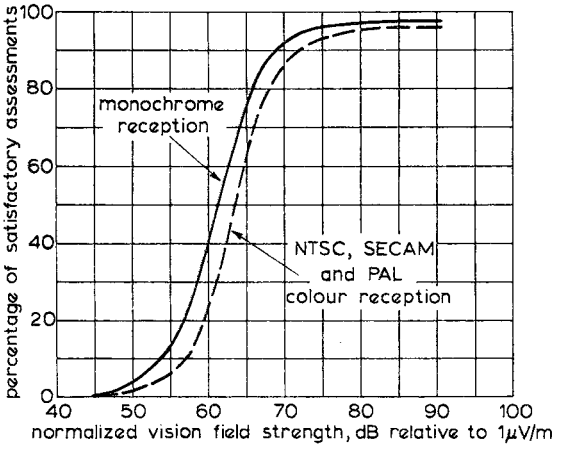
So far as objective (b) is concerned, it has always been realised that the most important of the factors influencing the quality of service at u.h.f. is the

signal-to-noise ratio, which is determined by the field strength. Nevertheless, it is possible that distortion associated with multipath propagation - for example, incorrect chrominance-to-luminance ratio in a colour signal, or the appearance of 'ghosts' - could render pictures unacceptable even when the field strength is high. It would be advantageous if such conditions could be rated by measuring some characteristic of the signal in addition to field strength.

2. DETERMINATION OF SERVICE AREA FROM OBJECTIVE MEASUREMENTS

2.1. Field Strength

During the 1957/58[1] and 1962/63[2] u.h.f. field trials, measurements of the sound field strength and subjective observations of the picture were made at each site visited by each mobile laboratory and it was found that the principal cause of picture impairment was receiver noise.[2,3] The information has been analysed to give the relationship between field strength and the percentage of sites receiving a satisfactory service and the curves obtained for monochrome and colour reception are shown in the figure. It will be noted that the horizontal scale of the figure is plotted in terms of normalised vision* field strength which is defined as the field strength required to provide a given grade of service on the assumption that the aerial gain, noise factor and feeder loss are all zero (in decibels) and that the vision carrier frequency is in Channel 44 (the mid-band frequency of Bands IV and V). The normalised field strength can be readily modified[2] to obtain the actual field strength required for any particular values of channel number, aerial gain, noise factor and feeder loss and the curves of the figure are therefore quite general. It is important to note that the curves of the figure give the probability of satisfactory reception as a function of normalised field strength. Thus, for example, if 100 sites were found, each of which had the same field strength of 64 dB above 1 μV/m, then satisfactory monochrome reception would be expected at 70 of the sites and satisfactory colour reception at 55 of the sites.



Relationships obtained for monochrome and colour reception during the 1957/58 and 1962/63 U.H.F. Field Trials

The curves shown in the figure have been derived from the whole of the measurements made during the field trials,[1,2,3] and are therefore representative of average conditions of terrain throughout the whole London area. It should therefore be possible to provide data for the prediction of cover in other areas by analysing separately the results obtained in the different types of terrain encountered.

* Although the measurements were of sound field strength, these have been converted to the equivalent vision field strength by the addition of 7 dB (the transmitted vision/sound ratio).

However, this analysis has been made and it has been found that the curves (of the type shown in the figure) corresponding to the extremes of terrain encountered do not differ significantly. Since the correlation between field strength and subjective picture quality shown by the curves in the figure is quite good, it can be concluded that they are satisfactory for determination of u.h.f. cover in all the types of terrain encountered in the London area. Inspection shows, however, that the variety of terrain is too limited to indicate whether a measurement of field strength is satisfactory for the prediction of cover in very hilly or mountainous areas where the signal strength is sufficient to render receiver noise unimportant. It must also be borne in mind that the curves of the figure can only form a reliable guide to u.h.f. cover when, as at present, the service area of a u.h.f. transmitter is limited by receiver noise. However, it is likely in the future that higher transmitter powers will become economical and that receivers with lower noise factors will become available. Under these conditions, receiver noise will become a less important cause of picture impairment and predictions of cover based on field strength will become less reliable unless, as appears likely, interference becomes predominant as a limitation of cover.

2.2. Response/Frequency characteristic

It is likely that reception in very hilly or mountainous areas will differ from that in the London area in that the incidence of multipath distortion will sometimes predominate. It was therefore thought that an analysis of the observations made at sites subject to multipath distortion might indicate whether an objective parameter other than field strength had a good correlation with subjective picture quality. In an area in which multipath effects predominate, the video spectrum of the received signal will vary significantly and there should therefore be a correlation between this and picture quality. The spectrum can be determined approximately by measuring the sound-to-vision and chrominance-to-luminance field strength ratios[4] and comparing them with the transmitted ratios. Large deviations of these ratios from the transmitted values should be indicative of severe multipath effects and thus some correlation between the ratios and picture quality would be expected. At a proportion of the sites visited during the field trials, multipath was found to be the principal cause of picture impairment. It was therefore thought that an analysis of these results might indicate a good correlation between spectrum non-uniformity and picture quality. No such correlation was, however, found and it seems likely that much of the multipath distortion was due to echoes of long delay (greater than 1 to 2 μs) since under these conditions, a relatively small echo (having little effect on the video spectrum) can give rise to appreciable picture impairment.

3. CONCLUSIONS

Field trials of monochrome and colour u.h.f. reception in the London area have shown that the principal cause of picture impairment is receiver noise and, as would be expected, there is good correlation between subjective picture quality and sound field strength. Curves relating field strength to the percentage of viewers receiving satisfactory colour and monochrome pictures have therefore been plotted and are used for the prediction of u.h.f. cover in areas in which noise predominates over the effects of multipath distortion. It must be remembered, however, that developments in transmitter design may eventually lead to the use of higher radiated powers.

In addition, receivers with lower noise factors are likely to come into general use. In the future, therefore, it is possible that receiver noise may not be the principal cause of picture impairment in all parts of the service area of a given transmitter. It is, moreover, certain that co-channel interference will become more important as more relay stations are built, and the field strength of the wanted station will undoubtedly provide a reliable guide to the occurrence of such interference. It is not yet known whether by this time multipath propagation will have become relatively unimportant.

In an attempt to improve the accuracy of the prediction of u.h.f. cover, the measurements made in different types of terrain in the London area have been analysed separately. The results of this analysis show, however, that the direct relationship between field strength and quality of the received picture does not vary significantly with terrain of a type within the range of those to be found in the London area.

On the other hand, in hilly and mountainous terrain, it is possible that the correlation between picture quality and field strength may be low and therefore the correlation between picture quality and video spectrum non-uniformity has been investigated. It has been found, however, that in so far as the London area is concerned, little or no correlation between video spectrum non-uniformity and picture quality exists, even in selected sub-areas in which multipath effects predominated over noise. It is therefore concluded that the prediction of u.h.f. cover in hilly and mountainous terrain where receiver noise is not always overwhelmingly predominant cannot be based on the results of the London area field trials.

4. REFERENCES

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